EVALUATE STATUS OF PACIFIC LAMPREY IN THE CLEARWATER RIVER AND SALMON RIVER DRAINAGES, IDAHO

TECHNICAL REPORT

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Abstract

Pacific lamprey *Lampetra tridentata* have received little attention in fishery science until recently, even though abundance has declined significantly along with other anadromous fish species in Idaho. Pacific lamprey in Idaho have to navigate over eight lower Snake River and Columbia River hydroelectric facilities for migration downstream as juveniles to the Pacific Ocean and again as adults migrating upstream to their freshwater spawning grounds in Idaho. The number of adult Pacific lamprey annually entering the Snake River basin at Ice Harbor Dam has declined from an average of over 18,000 during 1962-1969 to fewer than 600 during 1998-2006. Based on potential accessible streams and adult escapement over Lower Granite Dam on the lower Snake River, we estimate that no more than 200 Pacific lamprey adult spawners annually utilize the Clearwater River drainage in Idaho for spawning. We utilized electrofishing in 2000-2006 to capture, enumerate, and obtain biological information regarding rearing Pacific lamprey ammocoetes and macropthalmia to determine the distribution and status of the species in the Clearwater River drainage, Idaho. Present distribution in the Clearwater River drainage is limited to the lower sections of the Lochsa and Selway rivers, the Middle Fork Clearwater River, the mainstem Clearwater River, the South Fork Clearwater River, and the lower 7.5 km of the Red River. In 2006, younger age classes were absent from the Red River.

Introduction

The Pacific lamprey *Lampetra tridentata* is one of three lamprey species found historically in the Columbia River Basin (Close et al. 1995) and is the only species found in Idaho (Simpson and Wallace 1982). The other two species, river lamprey *L. ayresi* and western brook lamprey *L. Richardsoni,* are restricted to tributaries and mainstem areas of the lower and middle Columbia River.

The anadromous Pacific lamprey are indigenous to the Columbia and Snake river basins and are believed to have had a historical range in Idaho similar to Chinook salmon *Oncorhynchus tshawytscha* and steelhead *O. mykiss* (Simpson and Wallace 1982; Scott and Crossman 1998). As with other anadromous species in Idaho, Pacific lamprey no longer have access to habitats in the Snake River upstream of Hells Canyon Dam and in the North Fork (N.F.) Clearwater River upstream of Dworshak Dam (Figure 1).

Pacific lamprey exhibit a protracted freshwater residence in streams. Larvae (ammocoetes) emerge from their gravel redd two to three weeks after eggs are laid and drift downstream to settle in sand and silt depositional areas. The ammocoetes burrow into the substrate to begin a 4-7 year residency in freshwater before transformation into the juvenile stage (macropthalmia) and subsequent downstream migration to the ocean. This migration begins in late winter or early spring and continues into early fall. As Pacific lamprey macropthalmia enter the estuary or the ocean where their physiological process necessary to survive in a saline environment is completed. Pacific lamprey exhibit parasitic life strategies in their oceanic adult phase (Close et al. 1995) and may spend 20-40 months off the Oregon coast prior to beginning their inland spawning migration Kan (1975). Adult Pacific lamprey enter freshwater between April and June, eventually migrating into Idaho during the summer months. They move into over-wintering streams by September-October, and spawn the following spring. The mature adults spawn in gravel substrates and die within 14 days after spawning (Scott and Crossman 1998).

Hydroelectric dams in the lower Columbia and lower Snake rivers have contributed to the declines of Pacific lamprey populations by creating long, slow-moving backwater pools that prolong migrations. Additionally fish passage infrastructures, with their specific design and engineering attributes for other anadromous fish species, have proven to be obstacles to both upstream and downstream migration. Moser et al. (2002) documented an upstream passage efficiency of less than 50% for Pacific lamprey adults tagged below Bonneville Dam (Figure 1). Of those tagged below Bonneville Dam only 3% were documented above John Day Dam, although some Pacific lamprey undoubtedly migrated into tributaries between the three dams. Idaho's Pacific lamprey must surmount four dams on the Columbia River and four additional dams on the lower Snake River before entering Idaho. Potential habitats in headwater streams of the Clearwater River drainage may be up to 250 km from the mouth at Lewiston, ID.

Little attention has been given to the Pacific lamprey historically even though abundance has declined along with other anadromous fish species in Idaho. Historical documentation of Pacific lamprey is Idaho is scarce, as most information collected has been incidental to studies directed towards game fish species. This project was designed to build on life history information and determine status and distribution within the Clearwater River drainage of north-central Idaho.

Methods

Historical

We extensively reviewed both published and unpublished file data and literature that documented observations of Pacific lamprey in Idaho. This information dated back to the late 1800s as compiled by early U.S. Government naturalist explorations in the state. We also contacted a number of field biologists that may have had incidental observations of Pacific lamprey in Idaho's streams.

Dam Counts

We compiled total annual adult counts from U.S. Army Corps of Engineers published documents (USACE 2006) at Bonneville Dam on the lower Columbia River, and Ice Harbor and Lower Granite dams on the Snake River (Figure 1). For extended periods during the 1970s and 1980s, no Pacific lamprey adult counts were conducted at Bonneville and Ice Harbor dams. Idaho Department of Fish and Game (IDFG) file data provided information regarding Pacific lamprey adults enumerated at the Lewiston Dam located on the lower Clearwater River (rkm 1.5) at Lewiston from 1950 until its removal in 1972.

Recent Studies

We present data from seven years (2000-2006) of studies in the Clearwater River drainage of Idaho (Figure 1). In 2000-2002, we determined habitat preference of the species by electrofishing randomly selected 100-m reaches of the Red River, a major tributary of the South Fork (S.F.) Clearwater River. We utilized a Wisconsin ABP-2 electrofishing unit which was been designed with a dual-pulsed optional operational mode to increase efficiency collecting lamprey life history forms inhabiting substrates. At capture locations of ammocoetes and macropthalmia, we described the habitat by selected physical parameters (Claire 2003). Beginning in 2001 we initiated presence or absence surveys at selected stream locations throughout the Clearwater River drainage based on availability of habitat deemed suitable for occupation of both ammocoete and macropthalmia forms (Claire 2003; Claire et al. 2007). In 2002 we expanded our monitoring surveys outside of the S.F. Clearwater River drainage into the Middle Fork (M.F.) Clearwater, Lochsa, Potlatch, and Selway river watersheds. Beginning in 2002 we sampled annually over 100 established trend sites that were equitably distributed within these designated watersheds.

Dworshak Dam at rkm 3.1 on the N.F. Clearwater River blocked passage of anadromous fish in the early 1970s; however, Pacific lamprey ammocoetes or macropthalmia have been observed in the reservoir since then (Wallace and Ball 1978). In response to the question of whether or not the species may still reside upstream of the dam, we electrofished 23 sites in the N.F. Clearwater River and tributaries above the dam.

We also utilized records from downstream anadromous fish migrant rotary screen trap operations on six streams in the Clearwater River drainage to assist in determining abundance of Pacific lamprey in watersheds where these traps were operated. These traps are relatively inefficient at capturing ammocoetes or macropthalmia because of the small volume of stream discharge sampled and trap design which retains predominantly larger individuals in the catch. Information provided by these traps was considered important, but only supplemental to our electrofishing efforts. Three of the traps were operated by the IDFG in the S.F. Clearwater River watershed during 1993 to 2006. A scoop trap operated in Crooked River (rkm 1.0) was replaced with a 1.5-m rotary screen trap in 2002. Rotary screen traps of 1.5-m diameter were operated on the American River (rkm 3.0) and the Red River (rkm 5.0), from 30 March to 31 October.

Nez Perce Tribal Fisheries (NPTF) operated a 1.5-m rotary screen trap at rkm 21.0 on Lolo Creek (tributary to the M.F. Clearwater River), one at rkm 0.1 on Newsome Creek (tributary to S.F. Clearwater River), and another at rkm 1.0 on Meadow Creek (a lower tributary to the Selway River). The Lolo Creek trap is operated year around, weather permitting. Newsome Creek and Meadow Creek trap operations normally occur March to October each year. Records for the traps (1994-2004) were obtained from Nez Perce Tribe biologists (Sprague and Johnson, personal communication, NPTF) to augment our field data.

Following capture and anesthetization in a solution of MS-222 (methane tricanesulfonate) we documented total lengths and transformational stage of Pacific lamprey. We revived individuals in fresh water and released them near the capture sites. Data collected by electrofishing from all watersheds are presented as length-frequency representations of population composition. We compared population structures (using mean total lengths) in the S.F. Clearwater River and the Red River among even years using *t*-tests for means with pooled variances. Additionally, we analyzed minimum length and length frequency groupings to depict population structure changes between years. Population structural distributional changes over time were assessed based on comparative findings within the major watersheds. In order to reduce redundancy yet maintain strength and integrity of the data and not compromise identifying population trends, we included only the even year length-frequency data collected by electrofishing sampling.

Ageing

Basic information regarding age classes and length groups is useful for describing the relationships between adult escapement levels into Idaho and the relative abundance of ammocoetes and macropthalmia. Ageing of younger life forms is difficult, as all life phases of Pacific lamprey lack scales and otoliths by which traditional ageing techniques are employed. Meeuwig and Bayer (2005) used statolith structures to age Pacific lamprey ammoecoetes from the John Day River drainage in Oregon. We opted not to utilize this technique as it requires sacrificing individuals of various age groups. We did not believe that the abundance of ammocoetes in our study streams was at a level which would support removing any number of individuals without increasing the risk of further depression of populations in Idaho. Instead, we used techniques described by Pletcher (1963) and Kan (1975) that assigned age classes based on modal separation among length groups.

Results

Historical

Although Pacific lamprey are suspected to have been distributed historically throughout the range of other anadromous species, documentation of observations in Idaho has been less thorough than with other species and historical information as to their presence is scarce. The College of Idaho's fish collection has a limited number of Pacific lamprey documented from various streams throughout the Clearwater River drainage including Hatwai Creek (1968, one individual), Orofino Creek (1964, two individuals), Potlatch River (1967, one individual; 1977, 79 individuals), Lolo Creek (1969, 69 individuals), and the mainstem Clearwater River at rkm 20 (1978, 71 individuals). All of these waters are located in the lower or middle reaches of the Clearwater River drainage.

This collection also includes samples from sites in the N.F. Clearwater River drainage, including the mainstem (1966, three individuals; 1971, 84 individuals), Reeds Creek (1969, six individuals), and Dworshak Reservoir (1973, four individuals). In addition, ammocoetes were observed from Weitas Creek (Keating, 1958), upper Cayuse Creek in the early 1970s (Steve Pettit, personal communication, IDFG), and in Dworshak Reservoir (six individuals, 1988-89) (M. Maiolie, personal communication, Idaho Department of Fish and Game).

Hammond (1979) conducted the first dedicated study of this species in Idaho in the late 1970s. His work described life history characteristics of Pacific lamprey ammocoetes in the Potlatch River (Figure 2) and showed that Pacific lamprey ammocoetes and macropthalmia were relatively abundant throughout the mainstem Potlatch River. Collections at nine sites during the fall of 1977 throughout the watershed were comprised of 1,123 ammocoetes and 285 macropthalmia. These ammocoetes averaged 121 mm TL, ranging from 62 mm TL to 158 mm TL. Dr. David Bennett (personal communication, University of Idaho) noted that by the early 1980s no ammocoetes or macropthalmia could be found in the Potlatch River at Hammond's sample locations or other sites. In fact, failure of young age-class recruitment is apparent in Hammond's collections (Figure 2). The change in mean length of fish sampled at the stream's mouth during the fall months comparing 1977 (87 mm TL) to 1980 (108 mm TL) was highly significant ($t=-12.665$, $df=298$, $P<0.000$) and is strong evidence that Potlatch River Pacific lamprey recruitment was on the decline in the late 1970s.

Dam Counts

While there had been notably elevated peak counts in some specific years, the overall trend for the numbers of adult Pacific lamprey migrating from the Pacific Ocean into the Columbia and Snake rivers indicates an overall steady decline from 1938 to 2006. Adult counts at Bonneville Dam (Figure 3) on the Columbia River have declined from an average of 108,506 during 1938-1969 to an average of 48,948 during 1997-2006 (no data was available for 1970-1996) (Figure 3). Numbers of adult Pacific lamprey entering the Snake River basin at Ice Harbor Dam have declined from an average of approximately 18,000 (1962-1970) to less than 1,000 during 1993-2006 (no data was available for 1971-1977 and 1979-1992) (Figure 4). Pacific lamprey adults counted at Lower Granite Dam (Figure 5) and potentially entering Idaho have shown a relatively flat trend since 1996 with counts in 1998 and 2001 totaling less than 200 for both day and night counts.

Fish count records at the old Lewiston Dam on the Clearwater River documented upstream passage of adult Pacific lamprey (Figure 6) with the highest count of 5,300 adults documented in 1950.

Recent Studies

Our studies in 2000-2006 documented the distribution of captured Pacific lamprey ammocoetes and macropthalmia throughout the Clearwater River drainage as noted in Figure 7. We found no Pacific lamprey ammocoetes or macropthalmia in any of the 23 sites sampled in the N.F. Clearwater River drainage upstream of Dworshak Dam.

Electrofishing efforts in the S.F. Clearwater River drainage over seven years yielded a total of 1,760 ammocoetes and 12 macropthalmia (Table 1). While we found Pacific lamprey ammocoetes throughout the length of the mainstem S. F. Clearwater River, we found no ammocoetes or macropthalmia in any tributary other than Red River in the S. F. Clearwater River drainage. We only found ammocoetes and macropthalmia in the lower Red River downstream of rkm 7.5.

During this period no Pacific lamprey ammocoetes or macropthalmia were captured in the Crooked River and American River rotary screen traps while 373 ammocoetes and 30 macropthalmia were captured in the Red River trap (Table 1). Ammocoetes captured in this trap ranged from 65 to 170 mm TL (Figure 8).

In the three traps operated by NPTF, only a limited number of ammocoetes or macropthalmia have been captured since 1994. No ammocoetes or macropthalmia have been captured in Meadow Creek. Eight ammocoetes were captured in the Newsome Creek rotary screen trap located just above the mouth at (rkm 0.10) from 1998 to 2001; however, none have been captured since 2002. At the NPTF rotary screen trap (rkm 21.0) in Lolo Creek a total of 496 Pacific lamprey ammocoetes and macropthalmia were captured during 1994-2003 (Figure 9); however, trapping efforts have failed to capture any additional ammocoetes or macropthalmia since 2003. We did not electrofish any ammocoetes or macropthalmia in Lolo and Newsome creeks during our study.

We captured 812 Pacific lamprey ammocoetes from the Red River (Table 1). We captured one macropthalmia in the Red River during September 2001 and one partially transformed ammocoete/macropthalmia in September 2004. The largest ammocoete we captured in the Red River drainage during 2000-2006 was 171 mm TL in 2004 and the smallest Pacific lamprey ammocoete captured measured 72 mm TL in 2001 (Figure 10).

Length frequency analysis of ammocoetes captured by electrofishing in the Red River (Figure 10) showed that mean TL increased in the Red River over the seven years of study. The mean size of fish increased from 140 mm TL in 2000 to 170 mm TL in 2006 ($t=-12.494$, $df=16$, $P<0.000$).

In the S.F. Clearwater River drainage, we found Pacific lamprey ammocoetes less than 75 mm TL only in the mainstem S.F. Clearwater River. Pacific lamprey ammocoetes from the S.F. Clearwater River ranged from 47 mm to 169 mm TL. Macropthalmia (n=12) ranged from 115 to 161 mm TL during the same time. From 2000 to 2003 the mean total length of ammocoetes increased from 81 mm to 120 mm (Figure 11). In 2001 we sampled 12 locations in the mainstem S.F. Clearwater River and documented ammocoetes with a minimum length of 60 mm TL, compared to 47 mm TL in 2000 (Figure 11). However, beginning in 2004 and continuing into 2006, we documented ammocoetes less than 55 mm TL from upper reaches of the mainstem S.F.

Clearwater River (Figure 11). In the S.F. Clearwater River mean total lengths were significantly smaller in 2006 (70 mm) than in 2000 (81 mm) ($t=3.847$, $df = 215$, $P<0.000$) .

Our electrofishing in the Lochsa and Selway rivers in 2002-2006 resulted in collection of 559 and 538 ammocoetes, respectively (Table 1), but no macropthalmia. Ammocoetes less than 50 m TL were consistently represented in length frequencies of fish captured in these watersheds indicating some annual recruitment (Figures 12 and 13). Despite seeing annual recruitment, distribution remained restricted to below 85.5 rkm in the Lochsa River and 60.6 rkm in the Selway River.

The construction of Dworshak Dam in 1972 reduced anadromous accessible habitat in the Clearwater River drainage by 27.8%. While much of the remaining Clearwater River drainage is available for occupation by Pacific lamprey, the documented distributional stream mileage range in 2006 was estimated to be less than 40% of the area occupied in 1960 (Table 2).

Ageing

We assigned estimated ages to total length groups using annual growth increments of 30 mm (based on a hatching total length of 10 mm) for ammocoetes captured in 2006 for four streams (Lochsa, Red, Selway, and S.F. Clearwater rivers) (Figure 14). Using this approach, we determined that at least six age classes fit within the 175 mm maximum range. Age groups 0 through 4 were represented in the Selway River in 2006, while age classes 0 through 3 were found in the Lochsa River in 2006. Only ammocoetes in the age groups 4 or older were found in the Red River. Age classes 0 through 4 were found in the S.F. Clearwater River.

Discussion

Present day dam counts, current population composition data, and distributional sampling results support our premise that Pacific lamprey have not only declined drastically in abundance but also in distributional range in Idaho. The lower Selway and Lochsa rivers, the lower Red River, and S.F. Clearwater River are the only stream reaches presently occupied by Pacific lamprey. While salmon, steelhead, and Pacific lamprey are thought to have occupied much of the Clearwater River drainage historically, there is little supporting data identifying this is true for Pacific lamprey. Because of their adult migratory attributes, secretive rearing nature, and status as a nongame species, investigators may not have specifically targeted this species for collection. Even though historical field observations of Pacific lamprey were incidental during investigations of other more valued game fish species, there are a number of instances where the presence of Pacific lamprey was noted. Most historical observations have been in lower drainage waters, with the exception of ammocoetes observed in a small headwater stream (Cayuse Creek) in the N.F. Clearwater River drainage. Gilbert and Evermann (1894) also documented Pacific lamprey in upper watersheds in the Salmon River drainage These observations give us a reasonable perspective of historical distribution which was probably consistent with the distribution of Chinook salmon and steelhead into the upper reaches of most watersheds in the Clearwater River drainage.

Adult Pacific lamprey passage numbers over lower Columbia River dams have declined from 1962 through 2006. In the Snake River basin adult Pacific lamprey counts over Ice Harbor and Lower Granite dams have shown corresponding declines. Moser and Close (2003) addressed the inconsistencies of counting Pacific lamprey adults at lower Columbia River and Snake River dams. Nocturnal and seasonal migrational patterns play a notable role in portraying incomplete adult passage numbers. In 1997 the nighttime count at Lower Granite Dam was approximately ten times the daytime count, indicating that nighttime counts are crucial in determining total escapement into the Snake River basin within Idaho. Though official dam counts may not perfectly reflect the total number of fish in the river systems, the basic downward trend in abundance is clearly evident at all noted dams on both the lower Columbia and lower Snake rivers.

Even with the questionable efficiency of fish ladders at Lewiston Dam on the Clearwater River, adult counts there provided the only clear historical documentation of relative abundance of Pacific lamprey adults entering the drainage. In all cases records appear to be incomplete, as investigators may have focused on enumerating salmon and steelhead species rather than a non-game species like Pacific lamprey. The high count in 1950 of lamprey may represent an overall more intensive counting effort for all species than in previous years (Keating 1958), with a primary goal aimed at documenting the effectiveness of restoration of Chinook salmon in the drainage. Certainly the lack of present-day technology and the question of whether counts were also conducted at night, when a majority of Pacific lamprey would be expected to move, suggest the 5,300 lamprey counted in 1950 as a minimal estimate of the magnitude Pacific lamprey entering the Clearwater River drainage historically. Based on recent day and night counts at Lower Granite Dam and the magnitude of adults enumerated in the 1950s at Lewiston Dam, we estimate that the number of Pacific lamprey historically entering the Clearwater River drainage may have been in excess of 10,000 adults annually. Comparatively, the present day number of spawning adults in the Clearwater River drainage is estimated at fewer than 200 with less than one-third returning to the S.F. Clearwater River. This estimate is based on Lower Granite Dam passage of an average of less than 600 adults during 1998-2006 and the assumption of relatively proportional distribution of Pacific lamprey adults into the accessible major drainages of both the Snake and Clearwater River basins upstream of the dam.

Despite the declining trend of Pacific lamprey abundance in the Columbia and Snake river basins, Pacific lamprey still remain in a few Clearwater River drainage streams, but undoubtedly not at the abundance level found historically. Our 2000-2006 data reflects population at minimal numbers and distribution ranges restricted to remaining preferred habitat in the entire Clearwater drainage. During our seven year study we collected over 1,700 ammocoetes and 12 macropthalmia, compared to 1,123 ammocoetes and 285 macropthalmia collected by Hammond (1979) at only five sites in the Potlatch River in the fall of 1978. Pacific lamprey had disappeared in the Potlatch River system in the early 1980s. During the course of the our study, we determined Pacific lamprey were no longer present in Lolo and Newsome Creeks and may be on the verge of extirpation in Red River. Even though we sampled widely throughout the suspected historical range of the species (267 sites) in the Clearwater River drainage in 2002-2006, only 123 sites in the four major watersheds had Pacific lamprey present.

Prior to 2004 in the mainstem S.F. Clearwater River, smaller length groups were either missing or underrepresented, as there appeared to have been little or no recruitment for several years in the majority of the mainstem S.F. Clearwater River reaches. This lack of recruitment correlates with extremely low adult escapement numbers over Snake River dams during 1998-2001. After September 2004 we captured smaller ammocoetes in the very upper reaches of the S.F. Clearwater River. These smaller ammocoetes undoubtedly originated from a few discrete spawning sites and their subsequent dispersal did not occur until their second and third year of existence. The increased presence of smaller length groups (<95 mm TL) relates well with the 2002-05 spawning years in which greater adult escapement numbers were documented passing Lower Granite Dam.

The general movement of ammocoetes downstream (Pletcher 1963) could potentially affect the sampling results we obtained in such a manner that smaller size groups would be absent in a particular reach of stream. We concluded that movement of ammocoetes downstream over time could reflect lower abundance in future years, but ultimately a reduced proportion of each years younger age class would remain throughout the watershed albeit if in different proportion.

In our study we observed a lag between when fish were hatched (9-11 mm TL) and when they become most susceptible to electrofishing techniques at lengths greater than 40 mm TL. The absence or reduced numbers of ammocoetes in the smaller length groups (< 40 mm TL) is reflective of either a lack of recruitment, their secretive nature of residing in small-sized substrate, or inefficient immobilization by electrofishing gear. We recognized that electrofishing methods often are less efficient at capturing smaller individuals in a population. Dolan and Miranda (2003) found that fish size, represented as volume, is a key variable in collection success utilizing electrofishing. In their study smaller fish required a higher power output for immobilization. Our electrofishing techniques utilized a consistent power output geared to maximize immobilization over the range of fish sizes and minimize injury to all fish species inhabiting the streams sampled. As a result, we were effective in documenting recruitment several years after spawning occurs and with consistent effort we also found that younger, smaller individuals could be captured if present. This is reflected year in and year out in the Lochsa River and Selway River watersheds. We have utilized caution throughout the study in developing conclusions regarding population trend based on the presence or absence of ammocoetes less than 40 mm total length. However, when ammocoetes reach 40 mm and larger we had little difficulty capturing them and conclude that electrofishing provides a defendable tool to determine presence or absence, especially when combined with knowledge regarding preferred habitat.

Meeuwig and Bayer (2005) found no modal total length separation among age groups for Pacific lamprey collected in the Oregon's John Day River; however, they did observe separation in the western brook lamprey. Our data showed some modal separation for early age groups of Pacific lamprey, but not so for longer age groups because of moderate sample size and overlap of lengths between age classes. Because of the relative slow growth of Pacific lamprey ammocoetes we would expect overlap of age groups, particularly at larger sizes. However, our depiction of at least six age groups (including age 0) is consistent with their findings which utilized statoliths for ageing. The important aspect of assigning ages to length groups is to show that multiple age groups of Pacific lamprey are found in the Clearwater River drainage and that the presence or absence of smaller young age classes is reflective of whether or not there was successful recruitment.

Investigations identifying the habitat needs of Pacific lamprey in the Pacific Northwest (Pletcher 1963; Hammond 1979; Claire 2003; Stone and Barndt 2002) have documented Pacific lamprey utilizing habitat attributes which are generally only abundant in streams with high habitat complexity (leaf litter, woody debris of all sizes distributed in pool habitats, intact and well distributed pool habitat, well-sorted finer substrates including fine sand, silt, organic debris). Of all the watersheds within the Clearwater River drainage, the Lochsa and Selway rivers have the highest water quality (IDEQ 2007; Gerhardt 1993) and habitat suitability (Claire et.al 2003). The Selway River drainage is predominantly wilderness designation and the Lochsa River drainage is also designated wilderness on its southern side. Portions of the south side of the S.F. Clearwater River drainage are also within designated wilderness areas. The persistence of Pacific lamprey in the Clearwater River basin appears to be linked to these streams. Streams with impaired water quality and reduced habitat availability such as Potlatch River or Lolo Creek no longer support Pacific lamprey based on our work ending in 2006; even though, both these streams were documented to have the species present historically.

In the Clearwater River drainage, habitat alterations (related to road construction, general development, timber harvest related impacts, historical mining, others) have impacted habitat complexity in many stream reaches and generally altered the hydrological dynamics. These perturbations have significantly impacted hundreds of kilometers of rearing habitat. Activities such as timber harvest, mining, and overgrazing may have also indirectly affected habitat by reducing riparian canopy shade, altering sediment transport processes, and affecting nutrient movement into streams and rivers. However, in the Snake River basin, hydroelectric project development and operations are considered the predominant reason for the decline of Pacific lamprey in Idaho. While Pacific lamprey populations still persist in the Selway, S.F. Clearwater and Lochsa river watersheds, it is clear that the high quality water and habitat in these spawning and rearing streams has been incapable of maximizing production enough to reverse the dwindling trend in numbers of adult lamprey passing Lower Granite Dam.

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TABLE 1. Number of Pacific lamprey ammocoetes/macropthalmia captured in Clearwater River drainage streams. All fish were captured utilizing electrofishing except for the Red River trap.

Year	S.F. Clearwater River	Red River	Red River Trap	Lochsa River	Selway River	Mainstem Clearwater River
2000	93/0	154/0	15/1	--	--	--
2001	256/3	185/1	55/1	--	--	--
2002	107/0	274/0	125/20	61/0	64/0	1/0
2003	98/0	65/0	10/1	70/0	68/0	--
2004	91/3	86/0	102/1	55/0	76/0	--
2005	168/5	46/0	48/5	202/0	167/0	--
2006	135/1	42/0	28/1	171/0	163/0	0/0

TABLE 2. Pacific lamprey historical and current drainage area utilization in the Clearwater River drainage, ID.

Stream	Mainstem Length (km)	Estimated Mainstem and Selected Tributaries Occupied in 1960 (km)	Mainstem and Selected Tributaries Occupied in 2006 (km)	Change % in Occupied Mainstem and Selected Tributaries from 1960 to 2006
Clearwater R.	157.1	212.1	157.1	-25.9
Potlatch River	89.4	109.4	0.0	-100.0
N.F. Clearwater River	213.2	333.2	2.0	-99.4
S.F. Clearwater River	100.6	170.6	108.1	-36.6
Lolo Creek	56.4	71.4	0.0	-100.0
Selway River	147.3	170.0	85.5	-49.7
Lochsa River	112.9	159.9	60.6	-62.1
Totals		1226.6	413.3	Avg = -66.3

Figure 1. Selected drainages in the Columbia and Snake river basins with selected hydroelectric dams.

Figure 2. Comparison of Pacific lamprey ammocoetes captured by electrofishing in the Potlatch River at the same site near the mouth of the stream in 1977 (Hammond 1979) and 1980.

Figure 3. Annual total counts of Pacific lamprey adults during 1938 to 1969 and 1997 to 2006 passing upstream at Bonneville Dam, OR (USACE 2006). No counts were conducted from 1970 through 1996.

Figure 4. Annual total counts of Pacific lamprey adults passing upstream at Ice Harbor Dam, WA (USACE 2006). No counts were conducted during 1970-1992.

Figure 5. Annual total counts of Pacific lamprey adults passing upstream at Lower Granite Dam, WA. Night counts were discontinued after the 2002 season.

Figure 6. Total annual counts of Pacific lamprey adults passing upstream at Lewiston Dam 1950 and 1953 to1972, Clearwater River drainage, ID. No data were available for 1951-52. The dam was removed in 1972.

Figure 7. Sampling and observation locations for Pacific lamprey ammocoetes, 2000-2006. Each noted sampling and observation location represent relative stream reaches which may include multiple sampling sites.

Figure 8. Length frequencies of Pacific lamprey ammocoetes captured in Red River rotary screen trap (rkm 5.0), 2006.

Figure 9. Pacific lamprey captured annually (1994-2006) in the Nez Perce Tribal Fisheries rotary screen trap in the Lolo Creek (rkm 21.0).

Figure 10. Length frequencies of Pacific lamprey ammocoetes collected by electrofishing in the Red River, 2000, 2002, 2004, and 2006.

Figure 11. Length frequencies of Pacific lamprey ammocoetes collected by electrofishing in the S.F. Clearwater River, 2000, 2002, 2004 and 2006.

Figure 12. Length frequencies of Pacific lamprey ammocoetes collected by electrofishing in the Lochsa River, 2002, 2004, and 2006.

Figure 13. Length frequencies of Pacific lamprey ammocoetes collected by electrofishing in the Selway River, 2002, 2004, and 2006.

Figure 14. Estimated age groupings of Pacific lamprey ammocoetes captured by electrofishing in the Clearwater River drainage, 2006.


Washington
Montana
Columbia River
Lower Granite Dam
Lower Monumental Dam
Little Goose Dam
Dworshak Dam
Ice Harbor Dam
Bonneville Dam
The Dalles Dam
John Day Dam
McNary Dam
Columbia River
Snake River
Clearwater River
Salmon River
Hells Canyon Dam
Oregon
Salmon River
Snake River
Idaho
Lower Salmon Falls
N
W
E
S
Kilometers
0 20 40 80 120 160

Figure 1.

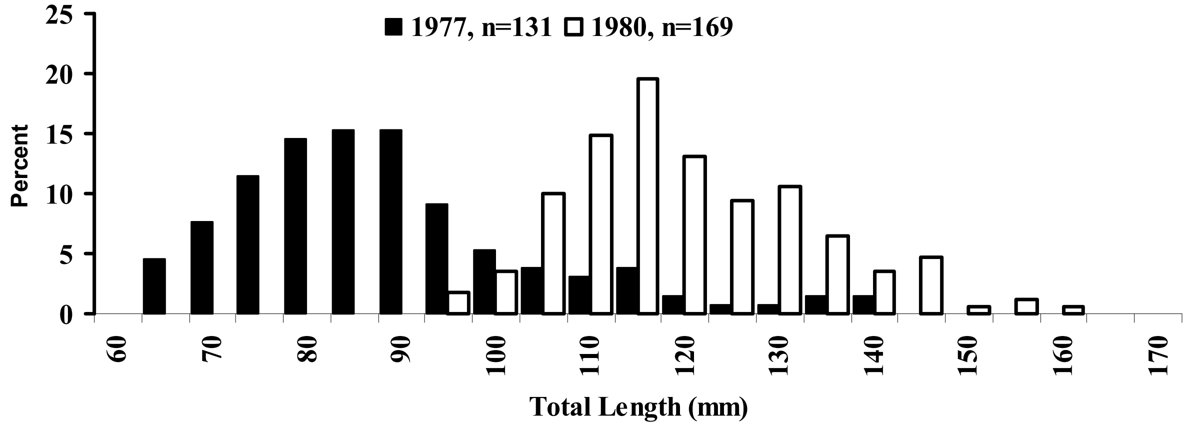

1977, n=131
1980, n=169
Percent
25
20
15
10
5
0
60
70
80
90
100
110
120
130
140
150
160
170
Total Length (mm)

Figure 2.

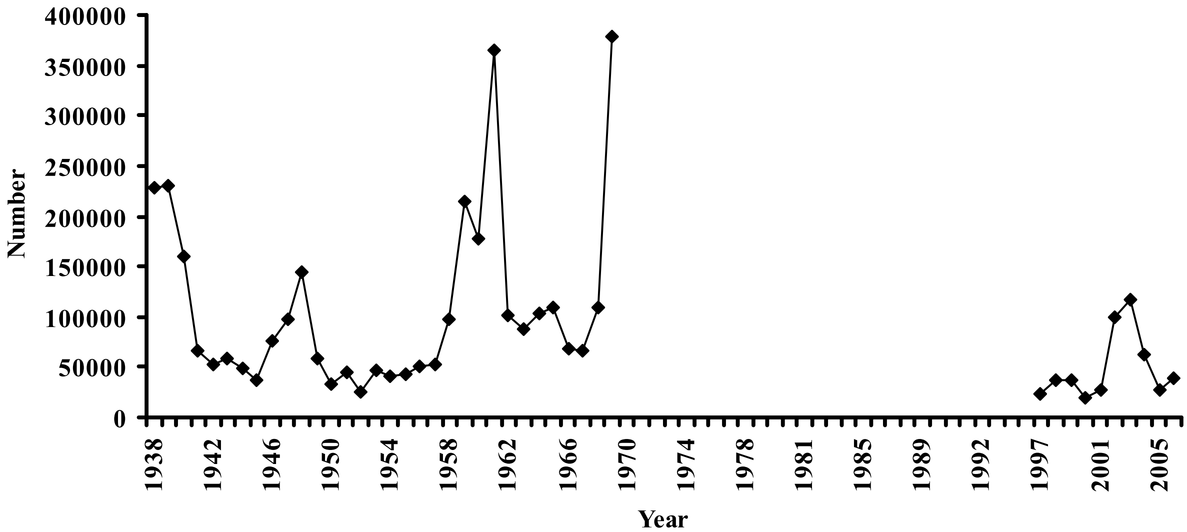
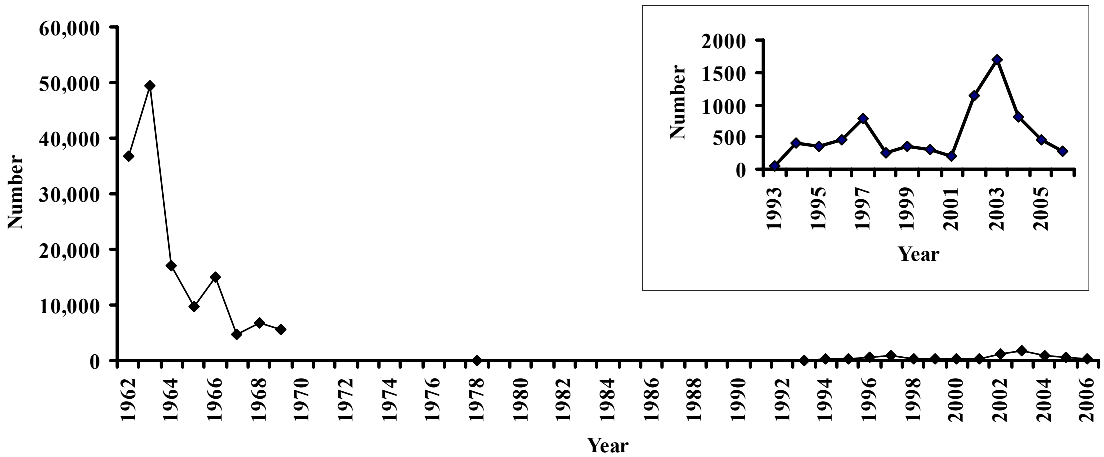
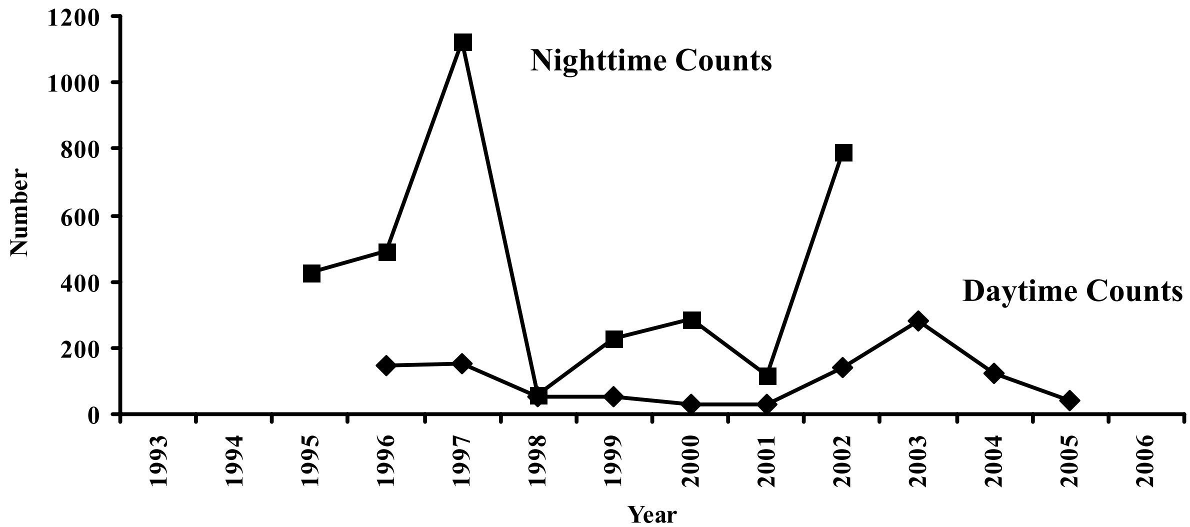

400000
350000
300000
250000
200000
150000
100000
50000
0
Number
1938
1942
1946
1950
1954
1958
1962
1966
1970
1974
1978
1981
1985
1989
1992
1997
2001
2005
Year

Figure 3.



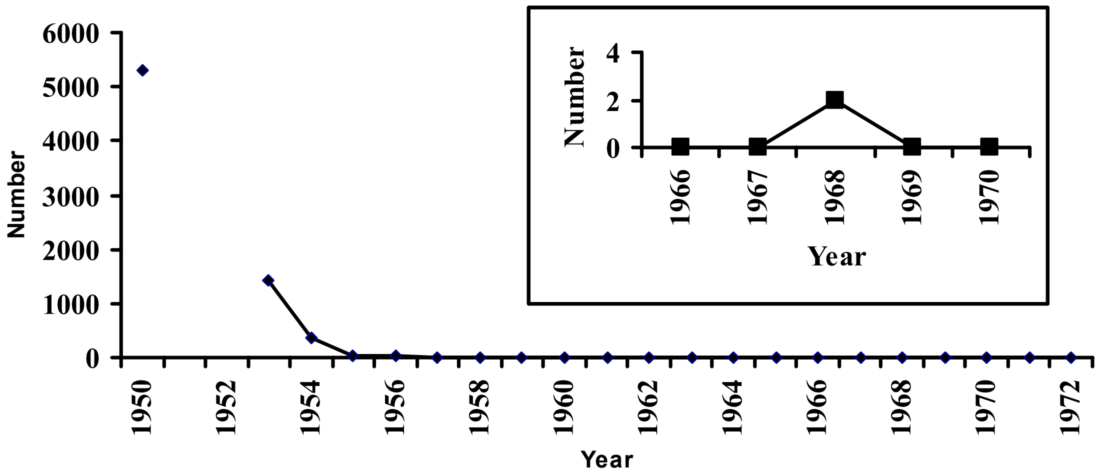
60,000
50,000
40,000
30,000
20,000
10,000
0
Number
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
Year
2000
1500
1000
500
0
Number
1993
1995
1997
1999
2001
2003
2005
Year

Figure 4.



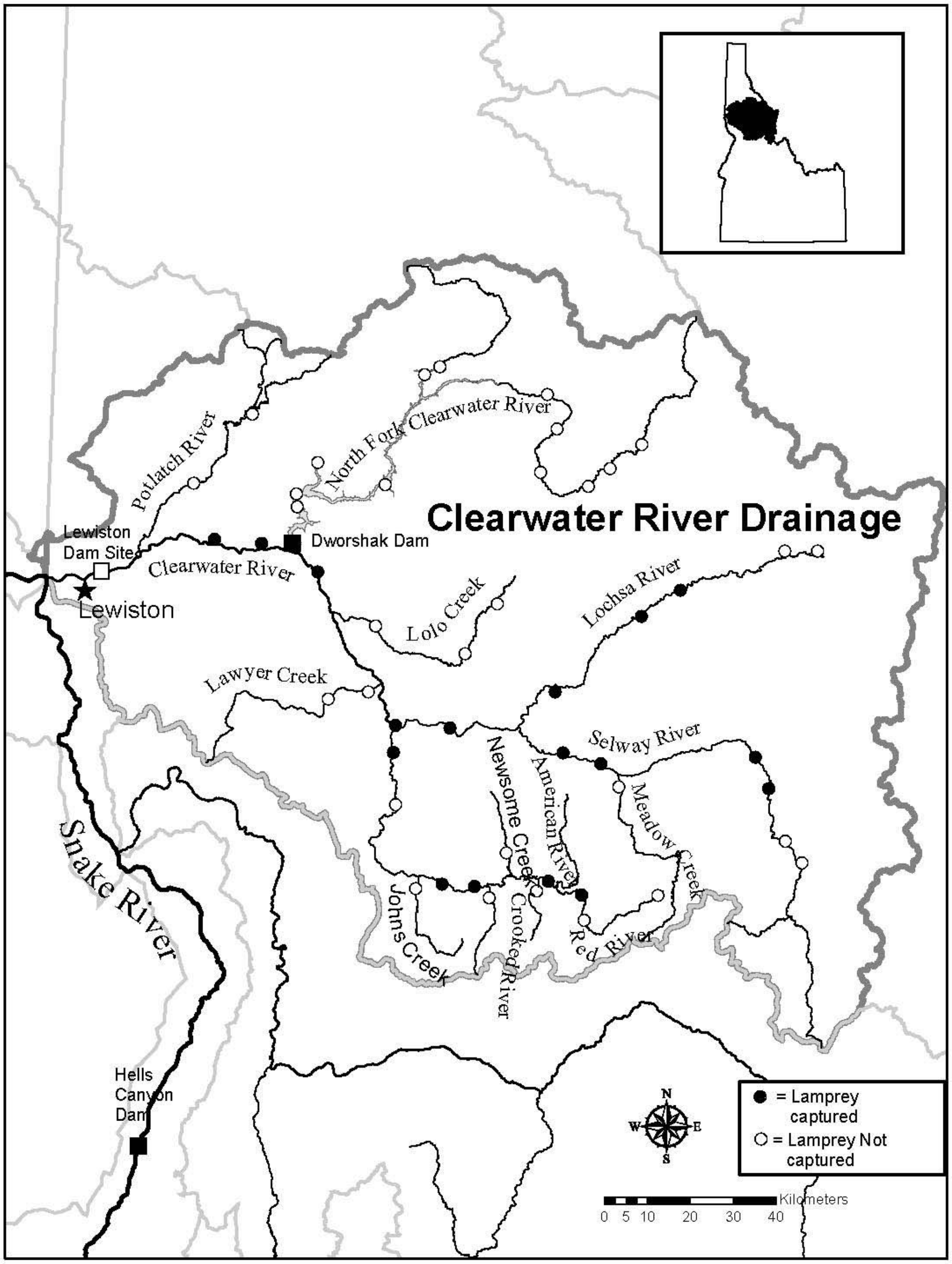
1200
1000
800
600
400
200
0
Number
Nighttime Counts
Daytime Counts
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
Year

Figure 5.



6000
5000
4000
3000
2000
1000
0
Number
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
Year
4
2
0
Number
1966
1967
1968
1969
1970
Year

Figure 6.



Clearwater River Drainage
Potlatch River
North Fork Clearwater River
Lewiston Dam Site
Dworshak Dam
Clearwater River
Lewiston
Lolo Creek
Lochsa River
Lawyer Creek
Selway River
Newsome Creek
American River
Meadow Creek
Snake River
Johns Creek
Crooked River
Red River
Hells Canyon Dam
N
W
E
S
● = Lamprey captured
○ = Lamprey Not captured
Kilometers
0 5 10 20 30 40

Figure 7.

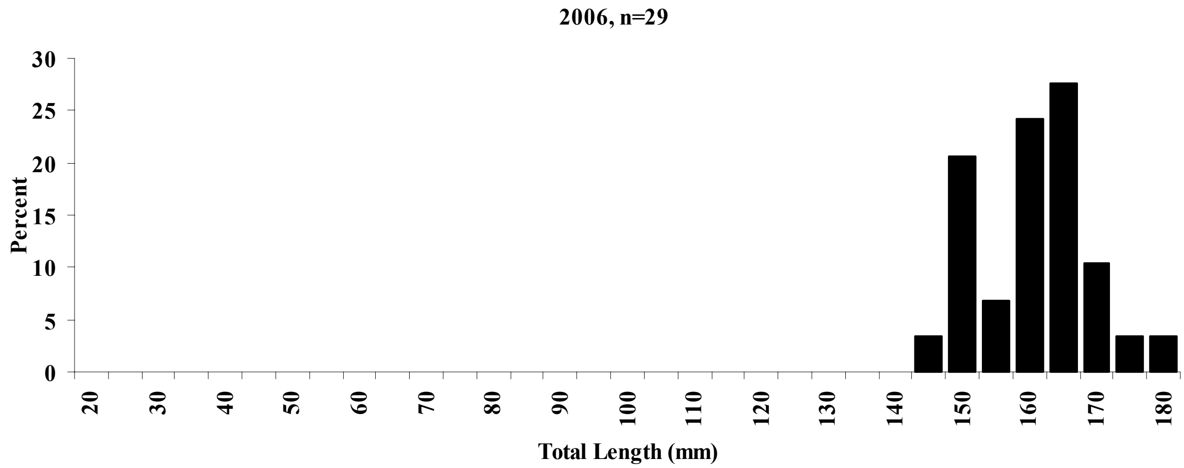

2006, n=29
30
25
20
15
10
5
0
Percent
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Total Length (mm)

Figure 8.

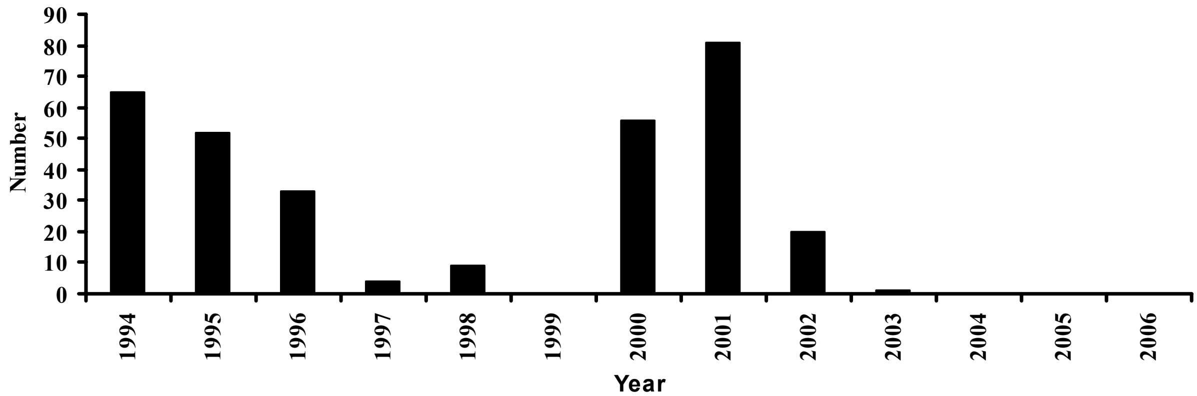

90
80
70
60
50
40
30
20
10
0
Number
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
Year

Figure 9.

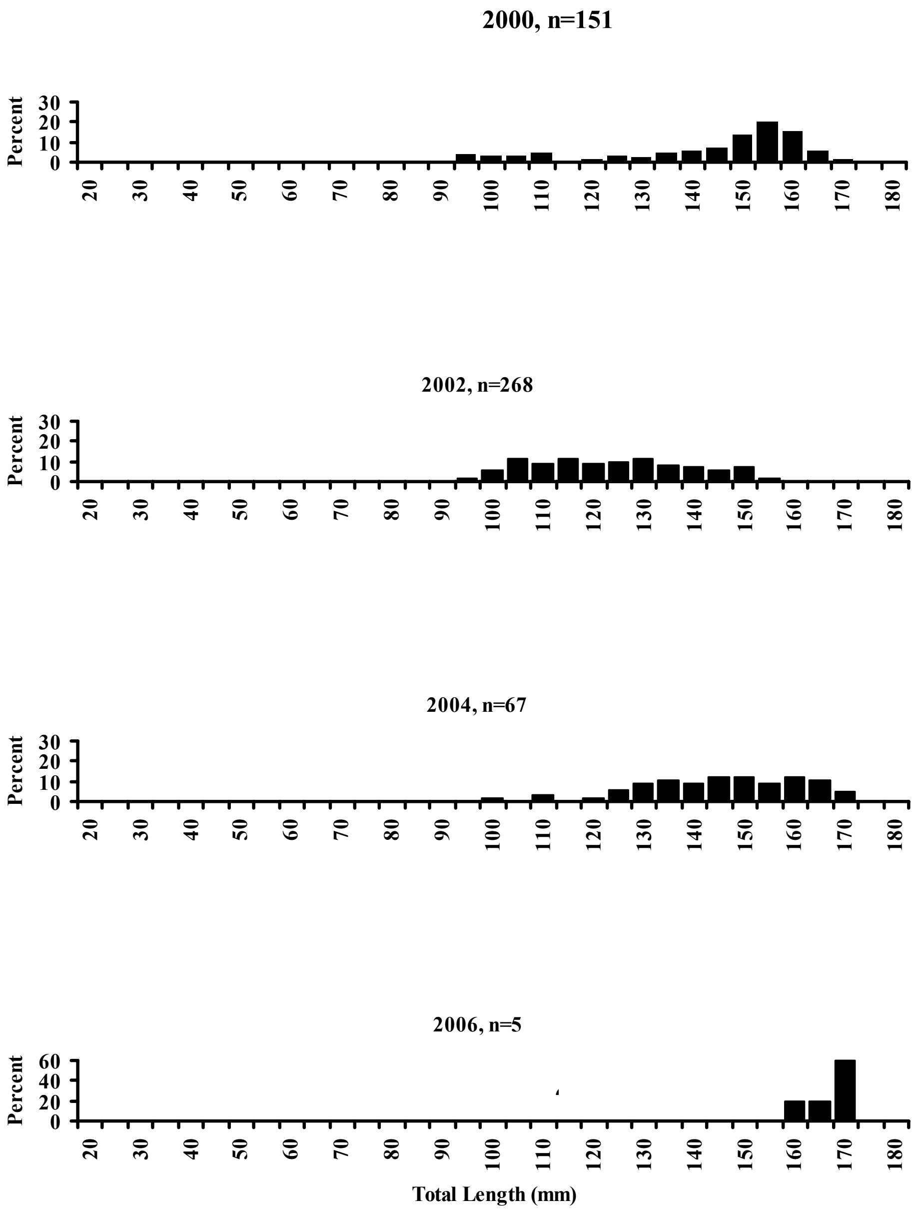


Figure 10.

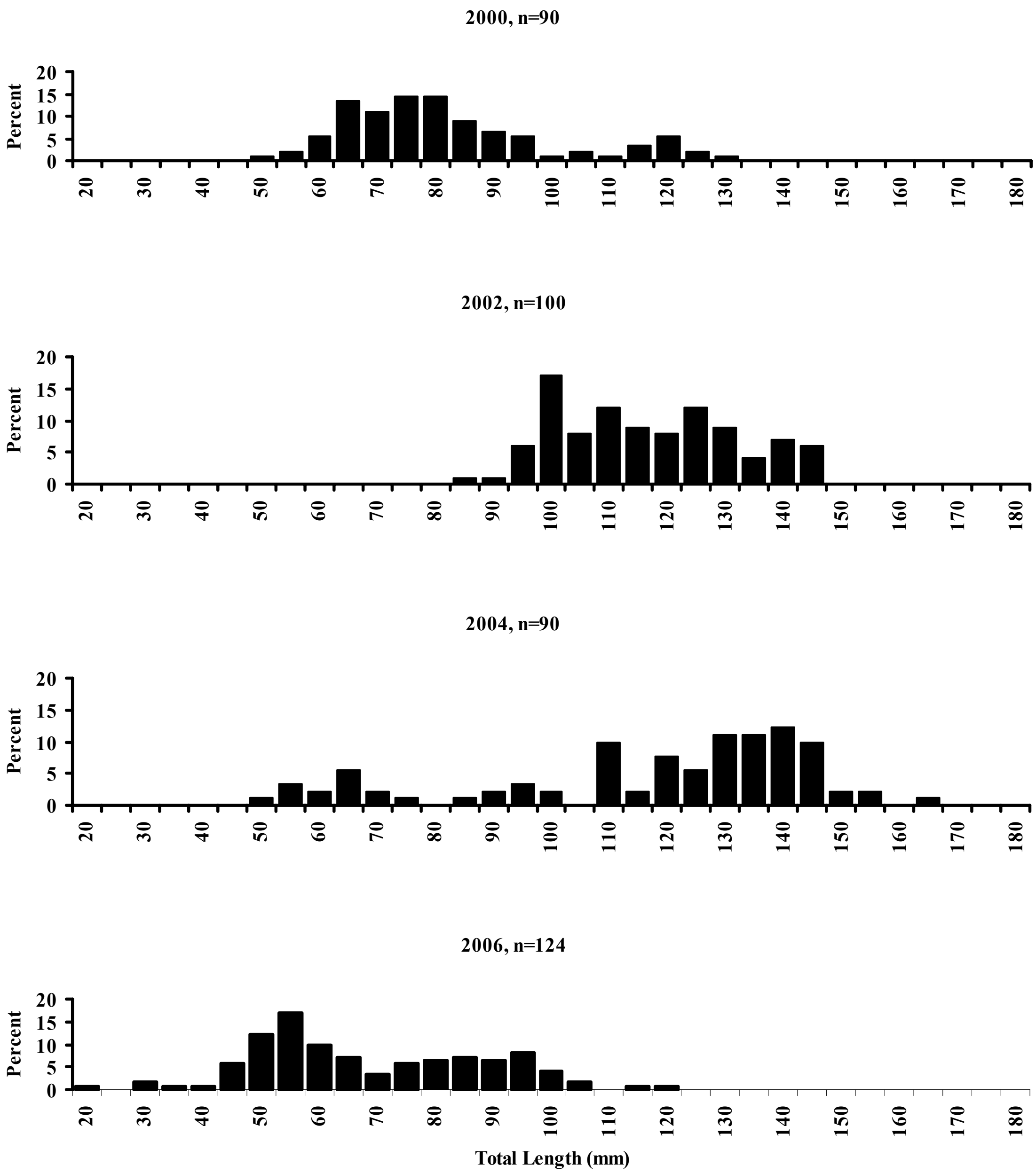

2000, n=90
2002, n=100
2004, n=90
2006, n=124
Percent
0
5
10
15
20
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Total Length (mm)

Figure 11.

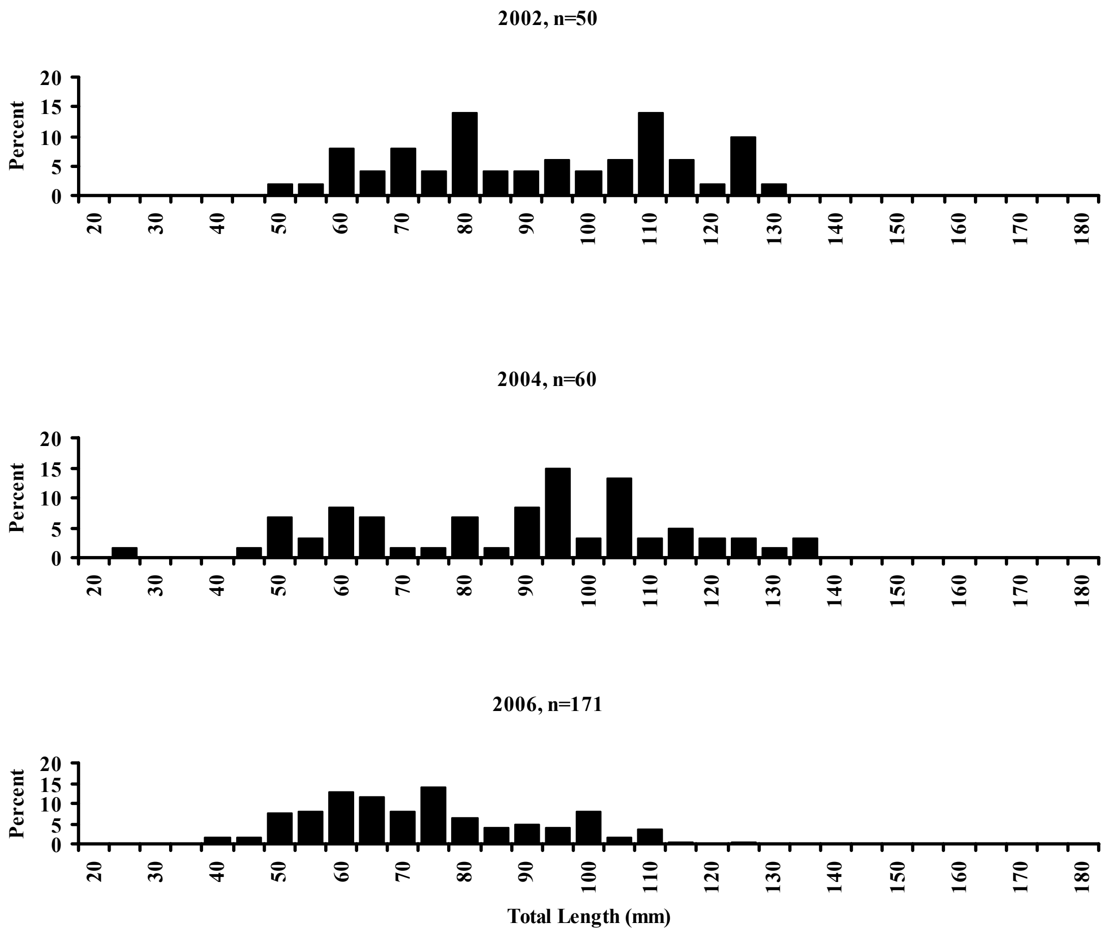

2002, n=50
Percent
20
15
10
5
0
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
2004, n=60
Percent
2006, n=171
Percent
Total Length (mm)

Figure 12.

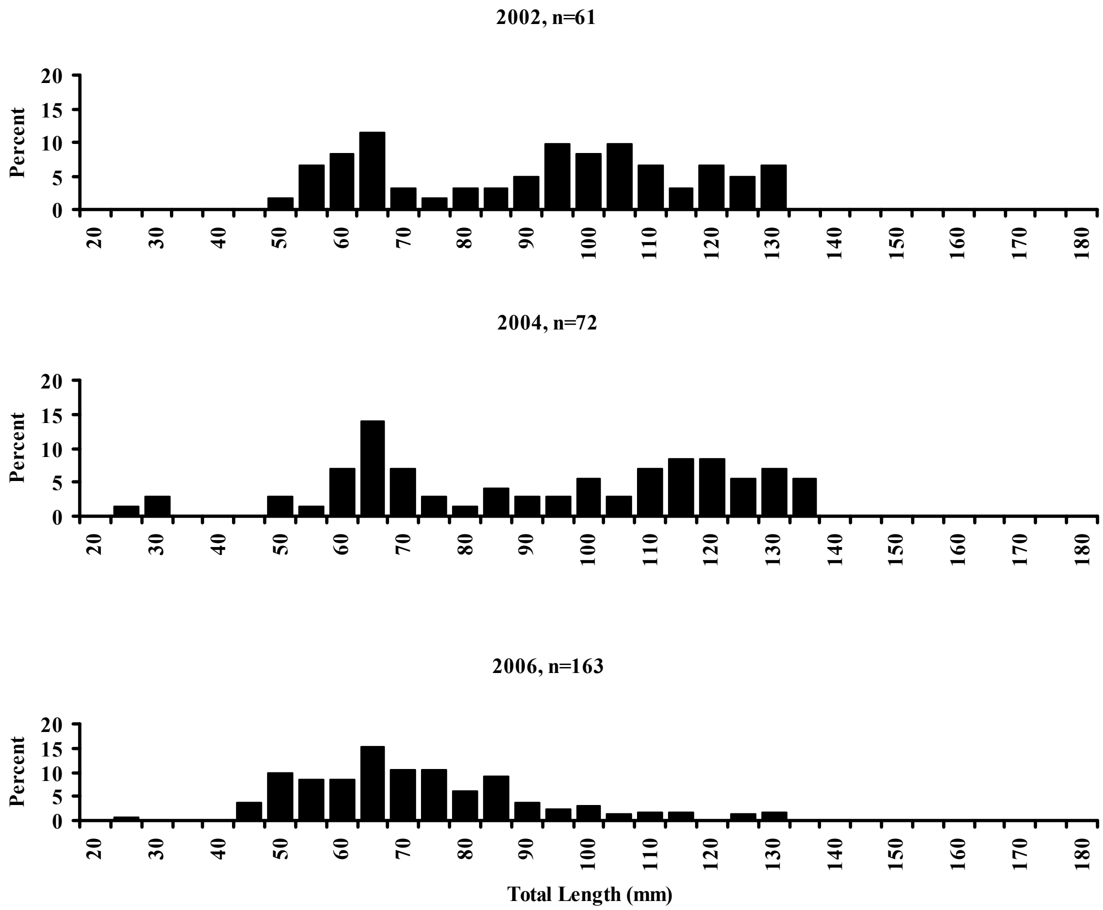

2002, n=61
2004, n=72
2006, n=163
Percent
0
5
10
15
20
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Total Length (mm)

Figure 13.

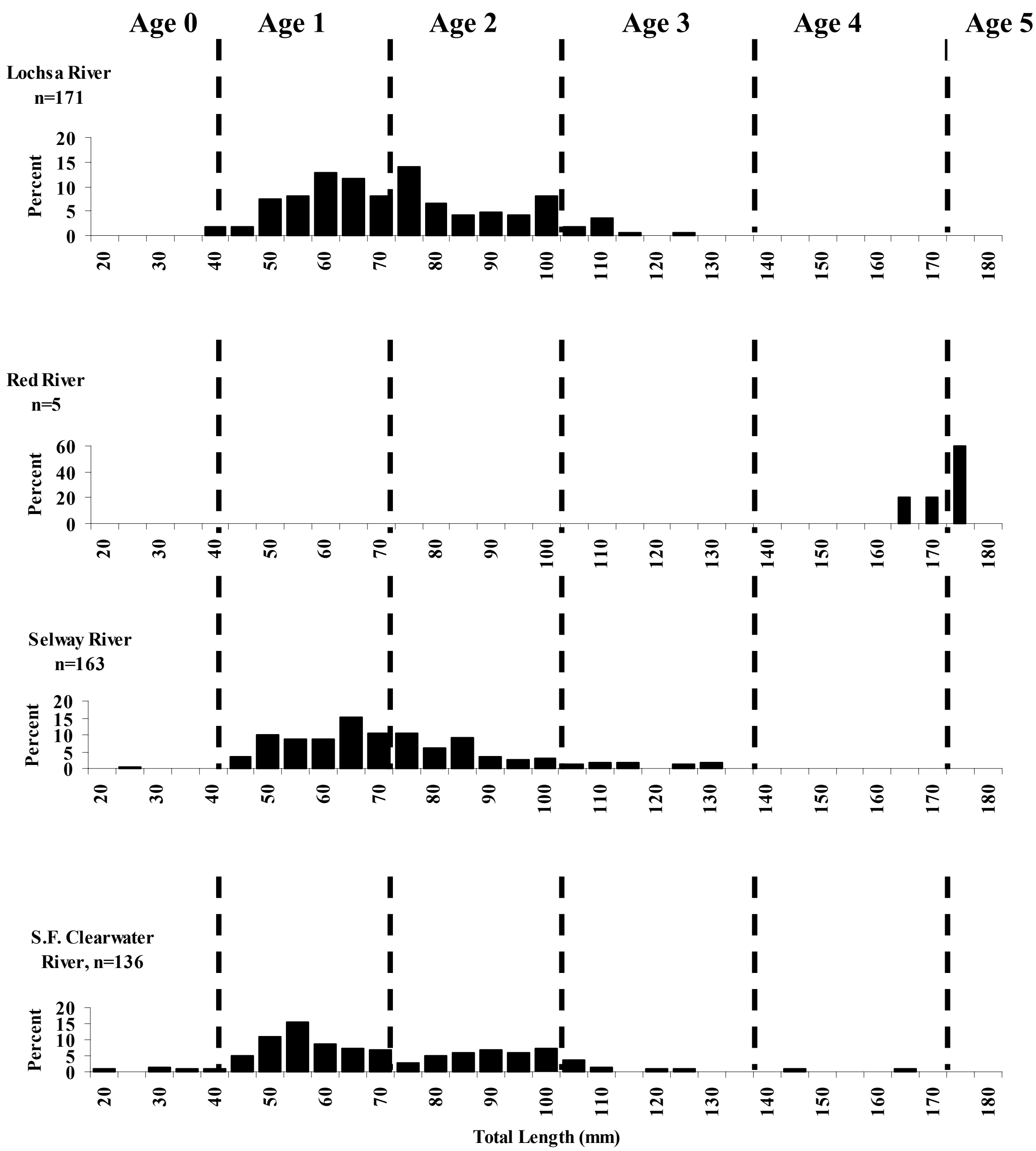

Age 0
Age 1
Age 2
Age 3
Age 4
Age 5
Lochsa River
n=171
Percent
20
15
10
5
0
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Red River
n=5
60
40
20
0
Selway River
n=163
S.F. Clearwater
River, n=136
Total Length (mm)

Figure 14.